THE IMPACTS OF SELECTED NUTRIENT SOURCES ON SOIL CHEMICAL PROPERTIES, GROWTH AND YIELD OF EGGPLANT (*Solanum melongena*)

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ABSTRACT

The study investigated selected nutrient sources on soil chemical properties, growth and yield of eggplant (Solanum melongena) using pot experiment. The research was conducted in Kabba College of Agriculture. The experiment was conducted in Complete Randomized Design using 4 treatments replicated five times. Each treatment consists of single pot with single plant. The treatments used were; NPK, Poultry manure, Cow dung and Control. Six parameters were used to achieve the objectives of the study; plant height, numbers of leaves/plant, stem girth, days to 50% flowering, numbers of fruit and fruit weight. Treatment means were separated using Least Significant Difference (LSD) at 5% probability level. The result showed better growth and yield performance by organic manures over NPK and Control. Plant height, number of leaves and stem girth were significantly higher in soil amended with Poultry manure (86.60cm, 137.60, and 5.30) while Cow dung treated soil had better yield in terms of number of fruits and weight of fruits (12.30 and 558.30). It revealed treatment had effect on soil chemical properties, Poultry manure and cow dung manures increase in organic matter (OM), N, P, K and Ca (3.14, 0.38, 6.3, 0.95, and 6.65); (3.63, 0.29, 13.42, 0.42 and 5.61) better than NPK and control (2.68, 0.22, 5.12, 0.37 and 3.75); (2.38, 0.19, 3.68, 0.34 and 3.62) respectively. The results showed that cow dung has great potentials for amelioration of degraded soils and improve growth and yield of eggplant.

Keywords: Nutrient, soil chemical properties, growth and yield of eggplant.

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INTRODUCTION

Vegetables (leafy and fruits) are broadly cultivated in most parts of sub-Saharan Africa, particularly, in the rural areas, and they constitute the most reasonable and feasible source of micronutrients in diets. Vegetables are considered essential for the diet of human in many parts of the world and play a significant role in human nutrition. They supply vitamins, minerals, dietary fiber and phytochemicals (João 2012). Eggplant known as aubergine is a plant belonging to the Solanaceae family and to the genus Solanum (Chérifa 2014). The family Solanaceae is prevalent in tropical and subtropical regions of South America. Eggplant cultivation is possible in varied climates (temperate, tropical dry or humid). It contains different species and varieties which are distinguished in particular by the color, size and shape of the fruits (Furini & Wunder 2004). The most cultivated species are *Solanum macrocarpon*, *Solanum melongena* and *Solanum aethiopicum* (Wei *et al*. 2019). Unlike *Solanum melongena*, which is native to Asia (Meyer *et al.* 2012), *S. macrocarpon* and *S. aethiopicum* are native to Africa (Daunay *et al*. 2001).

It is of great economic importance because several species are cultivated and consumed in the world (Combo *et al.* 2020). It is consumed on daily basis by urban families and also represents the main source of income for producing households in West Africa (Danquah-Jones, 2000). Eggplant nutritious value is comparable to the values of other common vegetables. Its fresh weight is composed of 92.7% moisture, 1.4% protein, 1.3% fibre, 0.3% fat, 0.3% minerals, and the remaining 4% consists of various carbohydrates and vitamins (A and C). It also contains water (about 92.5%), protein (1%), fat (0.3%), and carbohydrates (6%). Similarly, eggplant contains nutrients such as dietary fiber, folate, ascorbic acid, vitamin K, niacin, vitamin B6, pantothenic acid, potassium, iron, magnesium, manganese, phosphorus, and copper (USDA, 2009). With the growing consumption of garden eggs, there is a need to ensure high quality fruits with minimal or no sacrifice of quality and at the same time leaving the soil un-degraded chemically, physically and biologically (Eifediyi *et al*. 2016).

Nitrogen (N) is a major plant nutrient for most plants and can be applied in the form of urea, ammonium, nitrate and ammonium nitrate. These synthetic N forms, obtained through the Haber-Bosch process, are estimated in 2017 to produce about 120 Tg year−1 and is expected to reach 165 Tg year−1 by 2050, which comes with detrimental effects to the environment (Rao & Balachandar, 2017). The synthetic N forms produced through the Haber-Bosch process are expensive, limiting the use among small-scale and resource-limited farmers in developing countries. Organic farmers, small-scale and resource-constrained farmers, therefore, depend on alternatives such as N-fixing plants, compost and manure (including poultry manure PM), green manure, guano and bone meal as the primary N source for their crops. These organic N sources are primarily made available to plants through mineralization by soil microbes that convert the organic N to ammonium ions and nitrate for plant utilization (Mpanga *et al*., 2021).

The use of manure in crop production and pastureland is on the rise as a sustainable option due to many benefits, such as reducing nutrient management costs, improving soil health and crop yield (Hoover *et al*., 2019; Xia *et al*., 2017). Considering the adverse effects on soil health and the environment, the use of inorganic fertilizers is not advisable especially for vegetables because of chemical residue problems. In addition, fertilizers are scarce, beyond the reach of resource poor farmers, their continuous application results in soil acidity, degradation of soil properties and pollution of ground water (Ano & Agwu 2005). Organic fertilizers supply organic matter to the soil that modifies soils physical and chemical properties (Onwuka *et al.*, 2008). They are slow-release nutrient sources that make nutrients available for longer period of time (Omotayo & Chukwuka, 2009).

Poultry manure and cow dung manures are commonly available organic material source in Nigeria. Poultry manure is a primary fertilizer among small-scale farmers and farmers in developing countries such as Ghana and other African countries with low income due to its low cost. Other benefits include making heavy clay soils light to prevent the clay particles from binding together and increasing the cation exchange capacity (Mpanga *et al*., 2021).

MATERIALS AND METHODS

This study was conducted at the student's experimental field of the Horticultural section, Kabba College of Agriculture, Kabba, Kogi State. Kabba College of Agriculture is located in the Southern Guinea Savannah ecological zone of Nigeria 70 53' N, 60 02'E (Babalola *et al.,* 2011) with an average rainfall of about 1329 mm per annum with an average temperature range from 29°C - 30°C. It is four hundred and twenty-seven meter (427m) above sea level. (Kabba College of Agriculture Meteorology Station Field survey, 2011). The College occupies a total land area of about 350 hectares and situated approximately two (2) kilometer north of Kabba and is along Kabba-Ilorin Road.

The planting material used is an improved variety of garden egg seeds, polythene bags, shovel, and electronic weighing machine, and watering can, wheel barrow, lining peg, fertilizer, poultry manure, knapsack sprayer, insecticide and fungicide.
Seeds of eggplant (Kotobi) was used for the experiment. They were purchased from a reputable agro-allied company. It has a sweet taste, globular-slightly oblong shape, light green. Maturity is 55-60 days after transplant (Green seeds, 2021).

Experimental design and layout

The experiment was laid out in a Complete Randomize Design (CRD) with four treatments and five replicates. The treatments for the experiment were N.P.K 15:15:15 fertilizer, Poultry manure, cow dung, and a control (no manure/inorganic fertilizer). Poultry manure and cow dung was applied at a recommended rate of 9 t/ha and 20 t/ha respectively, NPK fertilizer was applied at 150kg/ha Nwokwu *et al*. (2020). It was purchased from a reliable agro allied industry in Kabba Market, Kabba, Kogi State. A nursery bed measuring 2 m x 1.2 m was prepared. The seeds were sown in row of 10 cm apart. The seed beds were watered and covered with mulch after sowing. After germination the mulch was removed and shade was erected to protect the young seedlings against direct sunlight. The seedlings were watered until they are ready to be transplanted after 4 weeks.

A total of 20 pots was used for the experiment, each weighing 10kg and were perforated at four spots at the base and four spots by the side to ensure effective drainage and aeration. Top soil was collected from the farm settlement area of Kabba College of Agriculture. The soil was air dried for three days to expose pests and some disease-causing organisms.

The experimental site was cleared manually and the bag of soils were placed accordingly.
Before transplanting of the eggplant seedlings, soil samples were collected from a depth of 0 - 30 cm using soil sampling auger and were composited, air-dried and sieved through a 5mm sieve and their physiochemical characteristics were determined before application of treatments maturity following standard laboratory procedure as recommended by Parr *et al. (*1989). The soil used for the experiment was analyzed twice, the first one before planting (pre-planting soil analysis) and the second after harvesting (post- planting soil analysis).

Cow dung and poultry manure obtained from nearby farms (Kabba College of Agriculture, Kogi State). The farm yard manures were cured and mixed thoroughly with the soil and also watered for two weeks before transplanting to allow for mineralization (Eifediyi & Remision, 2010).
Weeding was carried out at two weeks interval by handpicking within the pots and the use of manual hoe between the pots.

The field was regularly monitored for identification of diseases and insect pests. Z-Force (Fungicide) was sprayed at two weeks interval after emergence to ensure effective chemical control on important insect pests and fungi, respectively. Harvesting was done by carefully cutting mature berries free from the stalk with the use of bare hands. The harvested berries were then taken for data collection.

DATA COLLECTION

Data collected include:

Growth parameters at weeks after transplanting (WATP):

i. Number of leaves at 2, 4, 6, 8, 10 and 12 WATP: This was measured by counting the numbers of leaves present on the plant by physical observation.
ii. Plant height (cm) at 2, 4, 6, 8, 10 and 12 WATP: This was measured with the use of a meter rule by measuring the stem from the soil level to the apex of the stem.
iii. Stem girth (cm) 2, 4, 6, 8, 10 and 12 WATP: This was measured with the use of electronic vernier caliper.
iv. Days to 50% flowering: The number of days from planting to the time when 50% of plants initiate flowers.

Yield parameters

i. Number of fruits/plants: This was achieved by counting the number of fruits harvested per plant for each pot.
ii. Fruit weight (average): The fruits were weighed individually with a digital scale; the average weight was obtained and result given in kg/ha.

Statistical analysis

The data collected on various parameters were subjected to analysis using ANOVA. The means were separated using Least Significant Difference (LSD) at 5% probability level. All statistical analyses were done using SPSS (IBM version 20.0)

RESULTS AND DISCUSSION

Table 1: Pre-planting and post-planting soil analysis results

Soil Physiochemical properties	Values (Pre-planting)	(post-planting)			
		T1	T2	T3	T4
pH (H_2O)	6.20	5.61	5.95	5.91	6.11
OM (%)	2.62	2.68	3.14	3.63	2.38
Total N (%)	0.20	0.22	0.38	0.29	0.19
Available P (mg/kg)	5.28	5.12	6.3	13.42	3.68
Exchangeable cations (cmol kg^{-1})					
K	0.35	0.37	0.95	0.42	0.34
Ca	2.61	3.75	6.65	5.61	3.62
Mg	2.28	2.34	2.35	2.70	2.24
Particle size distribution (%)					
Sand	80.5	80.5	80.5	80.5	80.5
Clay	13	13	13	13	13
Silt	6.5	6.5	6.5	6.5	6.5
Textural class	Sandy clay loam				

Pre-planting Soil Result

Table 1 shows the pre-experimental soil physiochemical analysis results. The pre-soil analysis revealed the site to be moderately acidic (pH of 6.20), low in Organic Matter (2.62%), Total N (0.20%) and Available P (5.28) as well as low in exchangeable cation, K (0.35 cmol/kg), Ca (2.61 cmol/kg) and Mg (2.28 cmol/kg). The soil particle size percentage of sand, silt and clay (62.78%, 20.10% and 17.12% respectively) with soil textural class of sandy loam.

The pre-experimental analysis showed that the soil of the experimental site was low in soil nutrient status. This poor nutrient status of the soil may be as a result of leaching of basic cations, intensive rainfall and maybe due to the parent materials of quartz and sesquioxides which are poor in plant nutrients. This is in accordance to the findings of Nnaji *et al.* (2005) and Aberger (2006) who reported large losses of basic cations due to leaching and high intensity and duration of rainfall.

Post-planting Soil Result

The result presented in Table 1 shows the effect of different nutrient sources on chemical properties of the soil. It revealed that pH, organic matter, nitrogen (N), available phosphorus (P), potassium (K), and calcium (Ca) with respect to control were significantly affected by the application of soil amendment except for magnesium (Mg). Although, the value of pH, N, and K were similar for poultry manure and cow dung, however cow dung was superior to poultry manure in soil organic matter, N and available phosphorus. Application of different nutrient sources had no significant effect on magnesium, control had the highest in pH but had the least values in soil organic matter, N, available phosphorus, K, Ca and Mg. Application of organic nutrient sources improved soil chemical properties better than mineral fertilizer following from the observed values.

Furthermore, Organic treated soil slightly lower pH compared with the control, this could be due to the fact that during microbial decomposition of the incorporated manures, organic acids may have been released, which neutralized the alkalinity of the manures, thereby lowering the pH of the soil below their initial values. This is in line with the findings of Adekiya *et al.* (2019) who observed a similar trend in their work on organic amendments of soils. NPK fertilizer has the lowest pH as a result of leach base elements in the soil.

Table 2. Analysis of organic nutrient sources

Manure	pH(H_2O)	Organic C (%)	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Poultry	8.4	57.96	2.1	0.87	3.62	3.25	0.38
Cowdung	7.5	38.4	1.35	3.68	2.84	3.88	2.21

4.1.2 The chemical composition of the organic amendment

The chemical composition of the organic amendment used in the study are indicated in Table 2. It shows that the pH of poultry manure and the cow dung was slightly alkaline at 8.4 and 7.5 respectively while the Organic Carbon was higher in poultry (57.96 %) than cow dung (38.4%). Total N was moderate in cow dung at (2.1%) and poultry manure at (1.35%). Available P was low in poultry (0.87%) and high in cow dung (3.68%), Potassium was high in poultry (3.63%) than cow dung (2.84%), Cow dung was high in Ca (3.88%) than poultry (3.25%), and Mg was high in cow dung (2.21%) and low in poultry (0.38%) (Table 2).

Table 3: Effect of selected nutrient sources on height of eggplant (cm)

Treatments	Weeks after transplanting (cm)					
	2	4	6	8	10	12
T1	2.80[a]	5.72[b]	29.88[b]	62.80[b]	68.22[b]	74.40[b]
T2	1.94[c]	4.98[c]	27.72[b]	56.72[bc]	64.18[c]	71.63[b]
T3	2.52[b]	6.90[a]	38.32[a]	77.12[a]	81.62[a]	86.60[a]
T4	1.90[c]	4.78[c]	29.30[b]	52.58[c]	58.18[d]	64.20[c]
LSD	0.26*	0.54*	5.43*	9.87*	3.66*	6.89*

* = significant

Effect of selected nutrient sources on the plant height of eggplant (cm)

The effect of selected nutrient sources on plant height is presented in Table 3, it revealed that there is significant difference at 2, 4, 6, 8, 10 and 12 weeks after transplanting (WATP). At the first week after transplanting, pots treated with NPK recorded the highest followed by poultry manure while control recorded the least. However, Poultry manure gave the highest heights of plant; 6.90, 38.32, 77.12, 81.62, and 86.60 cm at 4, 6, 8, 10 and 12 WATP respectively. This indicates that poultry manure was able to release adequate nutrients for the growth of the eggplant. Jahn *et al.* (2004) reported that poultry manure contains essential nutrient elements associated with high photosynthetic activities and thus promote roots and vegetative growth.

Table 4: Effect of selected nutrient sources on number of leaves of eggplant

Treatments	Weeks after transplanting (cm)					
	2	4	6	8	10	12
T1	4.20[a]	6.60[ab]	22.80[b]	39.00[b]	51.75[b]	69.80[b]
T2	4.00[a]	8.00[a]	18.00[bc]	45.60[b]	54.60[b]	126.80[a]
T3	3.40[b]	8.00[a]	31.60[a]	70.60[a]	92.40[a]	137.60[a]
T4	3.40[b]	5.40[b]	15.60[c]	35.00[b]	39.00[b]	78.50[b]
LSD	0.27*	1.56*	5.63*	12.64*	16.31*	21.48*

* = significant

Effect of selected nutrient sources on the number of leaves of eggplant

The effect of selected nutrient sources on number of leaves is presented in Table 4, it showed that there is significant difference at 2, 4, 6, 8, 10 and 12 weeks after transplanting (WATP). The pots treated with NPK and Cow dung recorded more leaves 4.2 and 4.0 respectively at the first week. However, Poultry Manure treated pots produced plants with more leaves throughout 4-12 WATP (137.6) than Control

(69.8). This indicate that Poultry manure was able to release adequate nutrients for vegetative growth of eggplant.

Table 5: Effect of selected nutrient sources on stem girth of eggplant (cm)

Treatments	Weeks after transplanting (cm)					
	2	4	6	8	10	12
T1	1.48[a]	1.84[a]	2.76[b]	3.22[b]	3.56[b]	3.72[b]
T2	1.48[a]	1.92[a]	3.10[ab]	3.62[b]	3.88[b]	3.94[b]
T3	1.58[a]	2.04[a]	3.34[a]	4.30[a]	4.64[a]	5.30[a]
T4	1.46[a]	1.78[a]	2.88[b]	4.00[ab]	2.76[c]	3.50[b]
LSD	ns	ns	0.31*	0.41*	0.37*	0.46*

* = significant, ns = not significant

Effect of selected nutrient sources on the stem girth of eggplant (cm)

The effect of selected nutrient sources on stem girth is presented in Table 5, it revealed that there was no significant difference at 2 and 4 WATP. However, there was significant difference in the stem girth of eggplant at 6, 8, 10 and 12 WATP. The result further revealed that the application of Poultry manure gave the highest effect on stem girth throughout and at 12 WATP it recorded (5.30cm) than the other amendments and all the amendments were better than the control (3.50cm). This indicate that Poultry manure is able to decompose quickly and release nutrient to the soil.

Table 6: Effect of selected nutrient sources on days to 50% flowering of eggplant

Treatments	Days to 50% flowering
T1	12.40
T2	12.60
T3	12.80
T4	12.80
LSD	**ns**

ns = not significant

Effect of selected nutrient sources on days to 50% flowering of eggplant

In Table 6, the result showed that there was no significant difference in treatment effect on the number of days of 50% flowering of eggplant. NPK treatment pots had the shortest number of (12.40) days to 50% flowering, followed by poultry treatment pots (12.60) while the longest (12.80) days was at both cow dung and control pots. Pots treated with NPK fertilizer had plants that flowered earlier than other treatments including control. This could be attributed to the fact that a heavily nourished plant has the natural tendency to grow rapidly and therefore reaches maturity earlier than plant growing in poor soil. This is in accordance with the findings of Efediyi *et al.* (2009), who reported a response of watermelon flowering to fertilizer application.

Table 7: Effect of selected nutrient sources on number of fruit attributes and yields of eggplant

Treatments	Number of fruit/plant	Field yield (kg/ha)
T1	8.00^{b}	353.30^{b}
T2	12.00^{a}	558.30^{a}
T3	10.00^{ab}	470.86^{b}
T4	6.00^{b}	272.76^{d}
LSD	2.41*	21.63*

* = significant

Effect of selected nutrient sources on numbers of fruit and fruit yield of eggplant

Numbers of fruit

Statistical analysis showed a significant difference on the effect of selected nutrient sources on the number of fruits produced (Table 7). Highest number of fruits (12.00) was recorded at Cow dung treated pots while the least number (6.00) was in control and they differed significantly.

Fruit yield

The result in Table 7 indicated that there was significant increase in the fruit yield with Cow dung recording the highest (558.30) followed by Poultry manure (470.86) while control weighed the least (272.76). This can be attributed to the abundance of soil nutrient phosphorus which is essential for fruit setting and yield.

CONCLUSION

The results from the experiment showed that the use of organic nutrient sources (Poultry manure and Cow dung) was better for the improvement of soil chemical properties, growth and yield components of eggplant as compared to NPK and Control. Organic manures improved eggplant yield compared with NPK fertilizer and Control. Out of the two different organic manures tested, poultry manure produced significantly higher vegetative growth, however, Cow dung increase yield character of eggplant better because of its high soil chemical properties which could be related to its highest value in available phosphorus which is responsible for stimulating stronger bud, flower and fruit development.

RECOMMENDATION

The different organic manures increased the soil organic matter, N, P, K, Ca and Mg contents of the soil compared with control. The quality of applied organic materials had profound effects on the soil chemical properties. The results showed that cow dung has great potentials for amelioration of degraded soils. Therefore, the results would be useful in recommending the most effective soil organic amendment that will ensure satisfactory crop performance. It is recommended that the use of cow dung waste 20t/ha be adopted for eggplant production.

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